

Award Number: O1HQGROO37

3-D STRUCTURE AND TECTONIC INTERPRETATION OF THE CASCADIA CRUST
AND UPPER MANTLE FROM SHIPS AND EARTHQUAKE DATA

Robert S. Crosson, Professor
EARTH and SPACE SCIENCES
UNIVERSITY of WASHINGTON
BOX 351310
SEATTLE, WA 98195 -1310
(206) 543-6505 (Voice)
(206) 543-0489 (Fax)
crosson_La@u.washington.edu

Kenneth C. Creager, Professor
EARTH and SPACE SCIENCES
UNIVERSITY OF WASHINGTON
BOX 351310
SEATTLE, WA 98195-1310
(206) 685-2803(Voice)
(206) 543-0489 (Fax)
kcc&ess.washington.edu

-

Technical Abstract

-

We have produced a high quality 3-D seismic tomography image of the crust in the Puget basin region to a depth of approximately 30 km. Our model is based on a combination of earthquake and explosion data, and will provide the basis for improved earthquake locations incorporating 3-D structure, strong ground motion modeling studies which require accurate 3-D structure, structure and tectonic investigations, and other research. The Seattle basin (SB) is placed in the context of a series of sedimentary basins in the Puget lowland, including the previously undefined Muckleshoot basin SE of Seattle. The Seattle fault (SF) is imaged as a very rapid lateral velocity transition from the low velocity of the SB to the high velocity region south of the SF which we label the Seattle velocity high (SVH). The SVH lies between the Seattle and Tacoma basins, and is truncated eastward by the Muckleshoot basin. Although geophysical observations affected by shallow structure (e.g., aeromagnetic measurements) and surface geology have been interpreted to infer an EW orientation for the SF, our tomographic image clearly reveals that the deeper structure of the SF is an ESE trending lineation which is also truncated eastward by the Muckleshoot basin. The precise geometry of the SF is not resolvable with tomography, but the steepness of the velocity gradient across the fault indicates that it is high angle fault or steeply dipping thrust fault..

We have extended the tomography technique to include wide-angle reflection data, in particular to study the locations of deeper intraslab earthquakes in relationship to the structure of the subducted Juan de Fuca plate. This work reveals that earthquakes located within the Juan de Fuca plate lie within a dipping depth zone of approximately 7 km thickness, with a prominent reflector at or above the earthquake distribution. We interpret the reflector to be the Moho of the subducting plate, indicating that, at least in the central and southern Puget basin regions, intraslab earthquakes lie in the upper mantle of the subducting plate and not, as previously suspected, in the crust of the slab. If this result holds up under further tests, it will be an important constraint in trying to understand the origin of intraslab earthquakes. Since such earthquakes are an important hazard in this region, as witnessed by the 2001 M 6.8 Nisqually earthquake, understanding intraslab earthquakes must be a goal of earthquake hazard investigations in this region. In order to further our understanding of large intraslab earthquakes, we have undertaken a study of the source kinematics of the Nisqually earthquake using strong motion records from our regional network. These studies indicate a source duration of 6 seconds and slightly favor a nearly horizontal slip plane with rupture extending along the strike direction of the slab. The small number of aftershocks observed provide little constraint on the orientation of the slip surface for the Nisqually earthquake.